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मानक

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IS 5557 (2004): Industrial and Protective Rubber Knee and Ankle Boots [CHD 19: Footwear]



“ज्ञान से एक नये भारत का निर्माण”

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“Knowledge is such a treasure which cannot be stolen”

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औद्योगिक और संरक्षी रबड़ घुटना
और टखना जूते — विशिष्टि
(चौथा पुनरीक्षण)

Indian Standard

INDUSTRIAL AND PROTECTIVE RUBBER
KNEE AND ANKLE BOOTS — SPECIFICATION
(*Fourth Revision*)

ICS 13.340.10; 61.060

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BUREAU OF INDIAN STANDARDS
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FOREWORD

This Indian Standard (Fourth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Footwear Sectional Committee had been approved by the Chemical Division Council.

This standard was first published in 1969. In the original standard following three types of knee boots were specified for the popularly known English sizes 5 to 11 (Paris point 38 to 45) :

- a) Type 1 — Non-oil resistant,
- b) Type 2 — Oil resistant, and
- c) Type 3 — Fitted with protective steel toe caps.

Such boots were recommended for use in mines by the technical committee on miners' boot, set up by the Ministry of Labour and Employment, which in turn, had requested the Bureau of Indian Standards to formulate a detailed specification.

Type 1 Boots were intended for heavy duty purpose in engineering workshop, tanneries, and in construction industries, while Type 2 boots were intended for use where the floor is covered with oil and grease, etc, such as in workshop and garages.

Type 3 Boots were intended for use in mining industry where toe protection is needed. This classification remained unchanged during the first revision in 1992.

In the second revision an attempt was made to align this standard with ISO 2023 : 1973 'Rubber lined industrial boots — Specification'. However during implementation certain difficulties were faced by the Indian industry and based on the feedback the standard has been taken up for revision.

In the third revision the requirements of IS 10665 : 1982 'Safety rubber ankle boots for miners' were incorporated and an attempt was made to sort out the problems faced by the industry in implementation of IS 5557 : 1995. IS 10665 : 1992 has since been withdrawn and merged with this specification.

In the third revision the requirements for industrial boots (with steel toe cap) were excluded as it was felt that the so called industrial boots are often confused with the protective boots and the former can not substitute the later. The requirement for oil resistance was also included and that of adhesion excluded.

In this revision, industrial protective rubber boots are in three varieties, namely, industrial protective rubber boots, knee boots, half knee boots and ankle boots being Variety No. 1, 2 and 3 respectively are to have steel toe cap protection at toe and are to be produced in Type 1 and 2, that is, non-oil resistant and oil resistant respectively.

Similar products without steel toe cap will be required to be brought under specification of IS 3738 : 1998 'Rubber boots — Specification (*second revision*)' as the same deals with the similar line of products. Industrial protective boots are to have mandatory protection at toe and as such provision for boots without steel toe cap is taken out from the scope of this specification.

Indian Standard

INDUSTRIAL AND PROTECTIVE RUBBER KNEE AND ANKLE BOOTS — SPECIFICATION

(*Fourth Revision*)

1 SCOPE

This standard prescribes requirements, methods of sampling and test for industrial and protective rubber boots reinforced with protective steel toe caps for use in mines as well as for workmen in heavy metal industries and where the floor is covered with water, chemicals, oil, grease, waxes, lubricants etc.

This standard is not intended to cover boots for protection against electrical shocks.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revisions, and parties to agreement based on this Indian Standard are encouraged to investigate the possibility of applying the most recent editions of the Indian Standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard, definitions given in IS 2050 shall apply.

4 CLASSIFICATION

This standard covers the following three varieties of industrial protective rubber boots:

- a) Variety 1 : Industrial protective rubber knee boots.
- b) Variety 2 : Industrial protective rubber half knee boots.
- c) Variety 3 : Industrial protective rubber ankle boots.

Each variety is covered by two types as follows:

- a) Type 1 — Non-oil resistant
- b) Type 2 — Oil resistant

5 REQUIREMENTS

- 5.1 a) Boots, Type 1 — Non-oil resistant of Variety 1, 2 and 3.
- b) Boots, Type 2 — Oil resistant of Variety 1, 2 and 3.

5.1.1 Design

The boots shall be made of rubber with fabric lining as shown in Fig. 1, Fig. 2 and Fig. 3 respectively. The sole and heel shall be of anti slip design or as agreed to between the purchaser and the supplier. Design shown in the drawings are recommendatory only.

5.1.2 Size

The boots shall be made in sizes 5 to 11 conforming to fittings as prescribed in Paris point 38 to 45 (see IS 1638).

5.1.3 Thickness

The minimum thickness (rubber and fabric) of the boots of Type 1 and Type 2 for the various parts and components as indicated in drawings shall meet the requirements, as prescribed in Table 1 .

Table 1 Thickness at Various Parts of the Boots

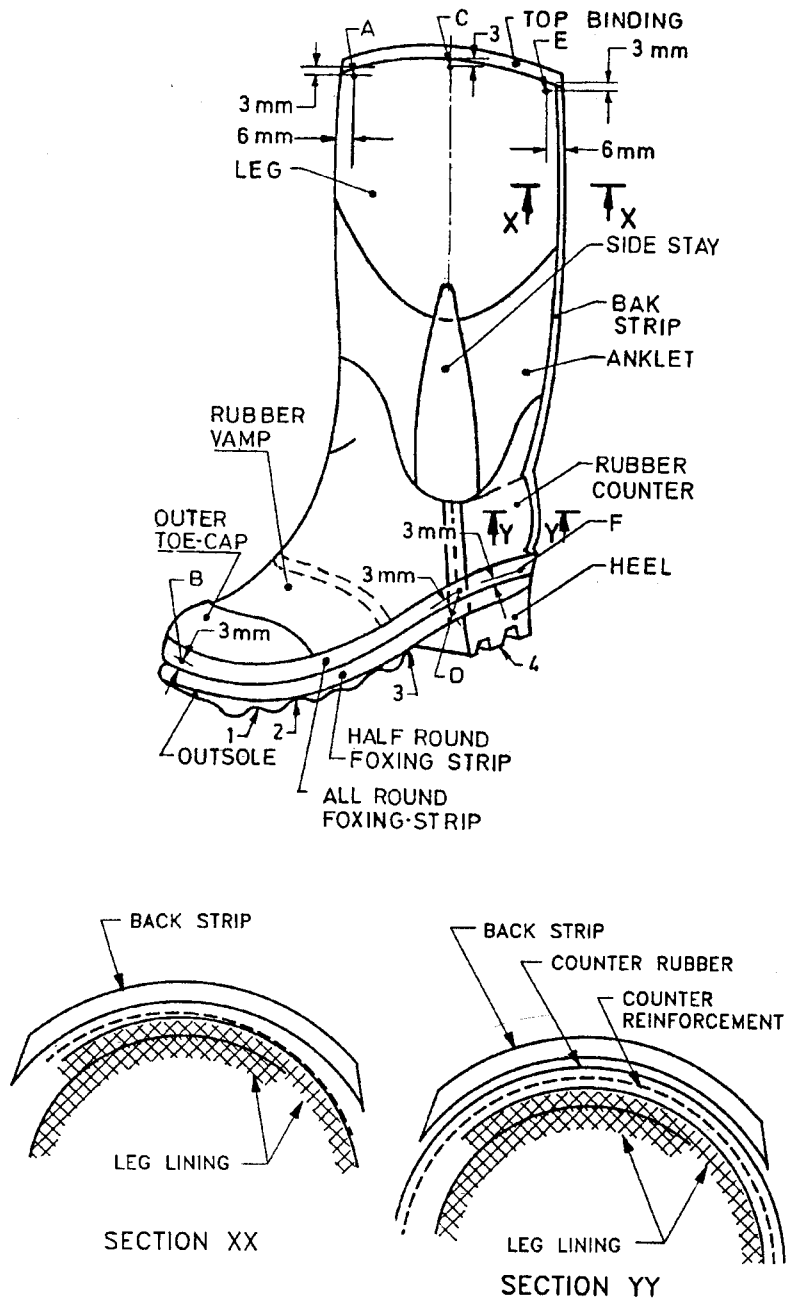
Sl No.	Part of Boot	Position as Indicated in Drawings (Fig. 1 to 3)	Minimum Thickness mm
(1)	(2)	(3)	(4)
i)	Leg	A	1.5
		B	3.5
		C	1.5
		D	3.5
		E	1.5
		F	4.0
ii)	Outsole:		
	At cleat	1	8.0
	Between cleat	2	2.0
	At waist	3	2.0
	Heel with cleat	4	22.0
iii)	Insole	—	2.5
iv)	Packing and filler (to be measured at green stage)	—	1.5

NOTE — Packing and filler, in moulded construction boots, may not be required to be provided.

5.1.4 Materials

5.1.4.1 Rubber components

The rubber components of the boots shall be non-porous and homogenous. These shall comply with the physical requirements as prescribed in Table 2.



Minimum Substance (Rubber and Fabric) of Boot in Various Parts

Parts of Boot	Position in Figures	Minimum Thickness
Leg	A	mm
	B	1.5
	C	3.5
	D	1.5
	E	3.5
	F	1.5
Outsole	1 At cleat	4.0
	2 Between cleats	8.0
	3 At waist	2.0
Heel	4	2.0
		22.0

All dimensions in millimetres.

FIG. 1 INDUSTRIAL PROTECTIVE RUBBER KNEE BOOTS

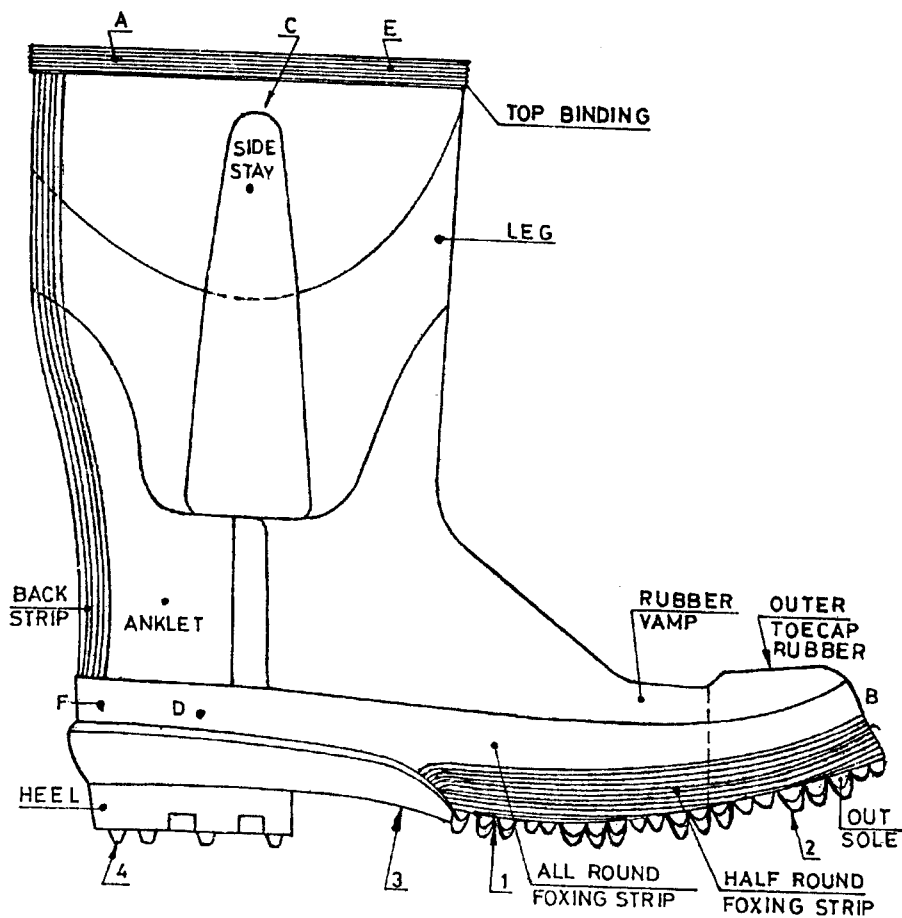


FIG. 2 INDUSTRIAL PROTECTIVE RUBBER BOOTS, HALF KNEE

Table 2 Physical Requirements of Rubber Components
(Clause 5.1.4.1)

Sl No.	Characteristics	Upper	Outer Sole and Heel	Method of Test, Ref to Indian Standard
(1)	(2)	(3)	(4)	(5)
i)	Relative density, <i>Max</i>	1.4	1.2	3400 (Part 9)
ii)	Hardness (IRHD) (<i>see Note</i>)	55 ± 5	60 ± 5	3400 (Part 2)
iii)	Change in initial hardness: After accelerated ageing at 100 ± 2°C for 24 h (IRHD)	—	+5 -0	3400 (Part 4)
iv)	Tensile strength Mpa (<i>Min</i>) for:			
	Type 1	—	10.5	3400 (Part 1)
	Type 2	—	8	
v)	Elongation at break, percent, <i>Min</i> :			
	For Type 1	—	250	3400 (Part 1)
	For Type 2	—	200	
vi)	Change in tensile strength after accelerated ageing at 100 ± 2°C for 48 h:	—	—	3400 (Part 1)
	For Type 1	—	+5 -25	—
	For Type 2	—	+10 -0	—
vii)	Change in elongation at break in percentage for Types 1 and 2	—	+5 -25	—

NOTE — Readings from 30 to 95 IRHD are approximately the same as those of shore durometer, Type 1.

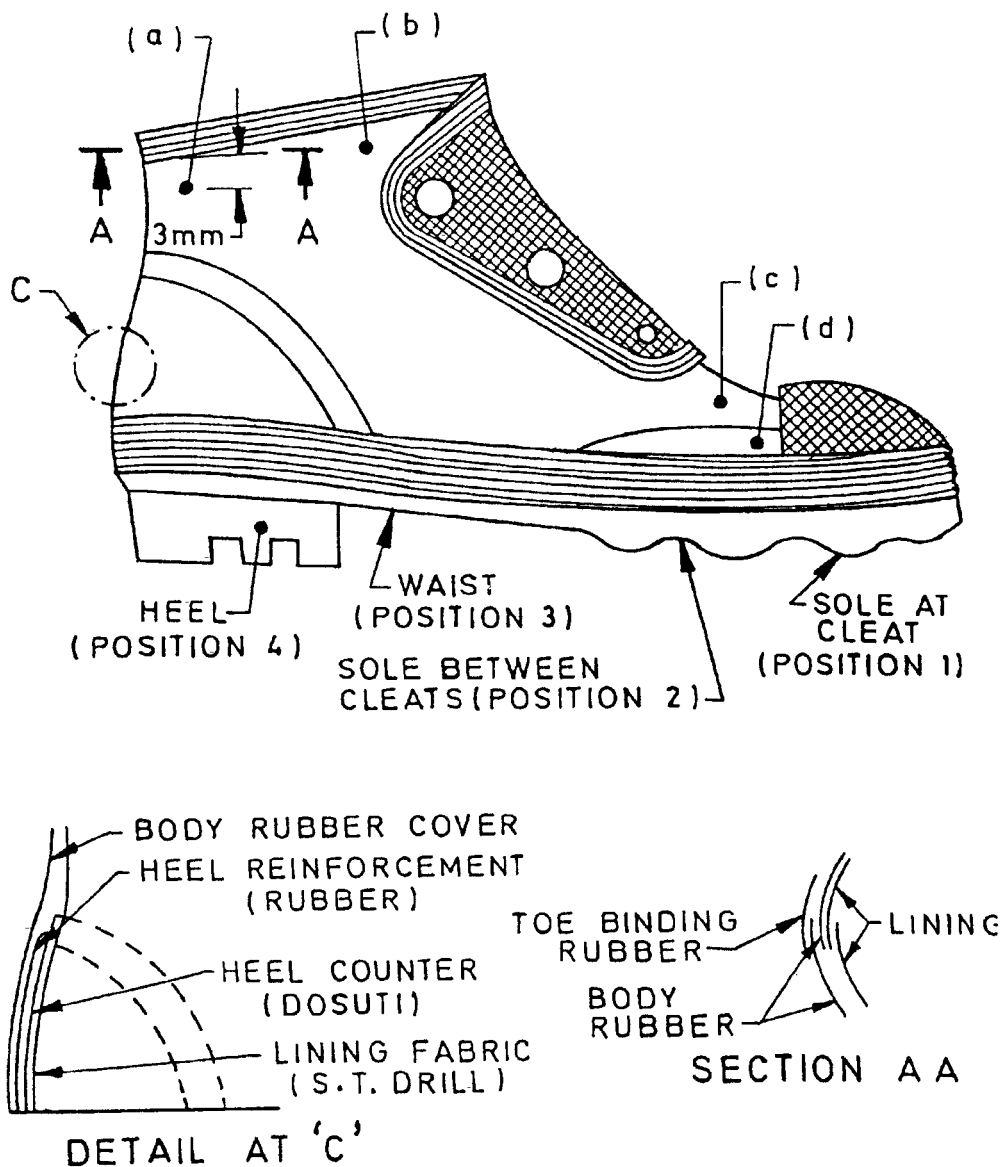


FIG. 3 INDUSTRIAL PROTECTIVE ANKLE BOOTS

5.1.4.2 Fabric

The upper shall consist of reinforcing fabric liner at leg, made of cotton or man made fabric or a suitable blend. Breaking load in warp and weft direction, shall not be less than 1 000 N and 550 N respectively when tested in accordance with IS 1969.

The reinforcing fabric for vamp and counter shall have a breaking load of 550 N in both warp and weft direction when tested in accordance with IS 1969.

The insole will be made out of cotton fabric having minimum breaking load of 1 000 N at warp and 550 N at weft, when tested in accordance with IS 1969. Insole fabric will be lined with suitable rubber compound/rubber sponge compound of rubber compound mixed with cotton flock.

5.1.4.3 Protective Steel Toe Cap

Protective steel toe caps, Type II, conforming to IS 5852 shall be used and shall match the shape and contour of the last.

5.1.5 Preparation of Test Pieces for Above Tests

The test pieces shall be cut from finished boots. If required, test pieces shall be reduced to the required thickness by careful buffing or by any other suitable method taking care to avoid an abnormal increase in temperature.

Test pieces may also be taken from standard vulcanized test slab prepared from the same rubber compound from which only the boot is manufactured.

Such test slabs will be subjected to the following checks:

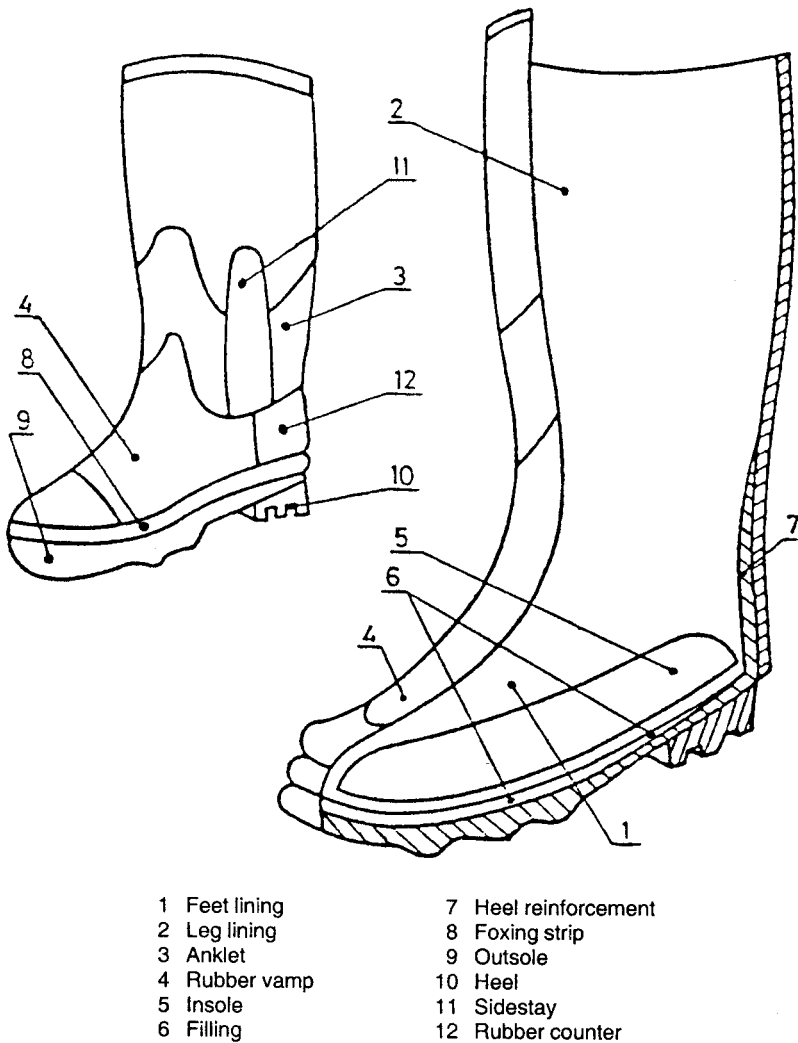
- Difference between the density as measured from sample drawn directly from finished boots and between the sample taken from the standard vulcanized test slab shall not differ by more than $\pm 0.05 \text{ g/c}^3$.
- Ash content does not differ by more than ± 0.5 percent when tested from the sample taken directly from standard vulcanized test slab.
- Value achieved from standard vulcanized sheet, made out of moulded rubber sheet of same rubber compound, used for production of footwear, will be 30 percent higher than

the value as prescribed in SI No. (iv) and (v) of Table 2.

5.1.6 Construction

5.1.6.1 Various components of the boots are to be prepared from the materials as prescribed in Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5 and Table 3. Fabric used as inner lining of the footwear shall be coated with rubber compound at one side and fabric used for reinforcement will be coated with rubber at both sides. Toe shall be fortified with protective steel toe cap with sponge as inside lining and as shown in Fig. 4.

5.1.6.2 Boots shall be made in vulcanized or moulded process or both.



These illustrations show the general location of parts, all of which are not necessarily included in the construction, or implied in the specification.

In the case of moulded boots, the terms indicate a particular area of the boot, rather than a separate part.

NOTE — This illustration is diagrammatic only and is not intended to illustrate detail of design.

FIG. 4 GENERAL LOCATION OF PARTS

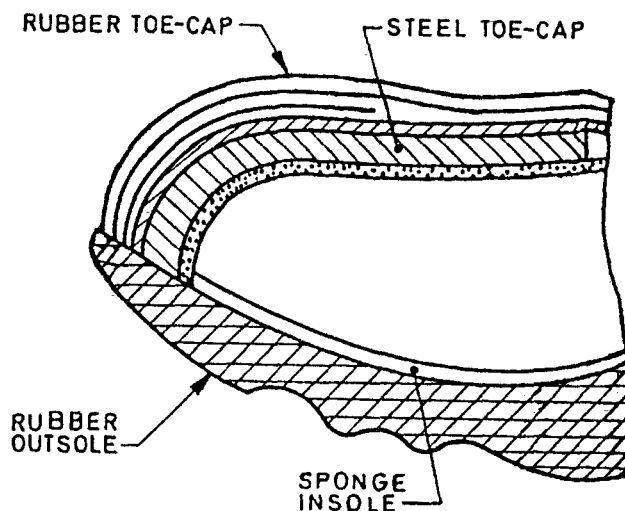


FIG. 5 CROSS-SECTION OF TOE OF A BOOT FITTED WITH PROTECTIVE STEEL TOE-CAP

Table 3 Material Requirement for Industrial Protective Rubber Boots

(Clause 5.1.6.1)

Sl No.	Components	Material
(1)	(2)	(3)
i)	Leg	Inside fabric / outside rubber
ii)	Vamp	do
iii)	Counter	Rubber fabric
iv)	Inner reinforcement at vamp	Rubber or rubberized fabric
v)	Heel piece	Rubber
vi)	Outer toe cap	do
vii)	Back strip	do
viii)	Foxing strip	do
ix)	Top binding	do
x)	Insole	Outside fabric / inside rubber or sponge or suitable rubber compound
xi)	Filler	Rubber or rubber with fabric composition
xii)	Outer sole	Rubber
xiii)	Heel	do
xiv)	Counter reinforcement or back strengthening piece	Rubber or rubberized fabric
xv)	Anklet	Rubber
xvi)	Full bellow tongue for Variety 3	Single texture rubberized fabric
xvii)	Snap fastener for Variety 3	Plastic / synthetic or any other suitable material as agreed to between the supplier and the purchaser

5.1.7 Physical Requirements**5.1.7.1 Heat treatment**

All rubber components shall be capable of withstanding, without developing any sign of brittleness or tackiness when aged at $100 \pm 2^\circ\text{C}$ at atmospheric pressure, in an air oven, for a period of 24 h in accordance with the method prescribed in IS 3400 (Part 4). On completion of the test the rubber face shall not show any sign of brittleness, tackiness, cracking or damage when viewed with unaided eye.

5.1.7.2 Composite strength

The strength of the composite upper when tested in accordance with method as prescribed below shall be such that it withstands a minimum average breaking load of 300 N in both directions at vamp and 500 N being minimum average breaking load in both directions at upper (leg):

From the upper (leg) and vamp portions of the boot, representative sample of width 25 ± 0.5 width is to be cut along the length of the boot of enough length so as to make it convenient to allow a distance of minimum 25 mm between the jaws of the tensile testing machine.

Rate of traverse of the pulling jaw shall be 100 ± 10 mm, *Min.* Three pieces from each direction will be required to be obtained from the made up footwear and will be subjected to test to break each test piece.

Mean value of results for each size are to be taken for record.

5.1.7.3 Flexing endurance

The vamp portion of upper and sole shall withstand continuous flexes as prescribed in Table 4 and when tested in accordance with the method prescribed in

Annex B. The samples for flexing endurance shall be taken after the same samples are aged and tested and conform to the requirements prescribed in 5.1.7.1.

Table 4 Number of Flex Cycles for Boot Upper and Sole
(Clause 5.1.7.3)

Sl No.	Position of Individual Test Pieces	No. of Flexes <i>Min</i>	Result
(1)	(2)	(3)	(4)
i)	Upper (Vamp portion)	12 5000	No crack
ii)	Outsole	60 000	No initial crack

5.1.7.4 Leakage resistance test

Finished Boots excepting Variety No. 3 will be sealed from the top and will be subjected to minimum pressure of 15 kN/m^2 and will be immersed in water. Boots will be immersed in a manner that 75 mm from the top of the boot will remain outside the water for a minimum duration of 2 min and will be examined for escape of air, and there shall be no leakage.

For Variety No. 3 the boots will be immersed in water up to a depth of 60 mm from the bottom of the boot without application of any air pressure for a duration of not less than 30 min.

There will be no wet feeling inside the boot and no seepage of water will take place.

5.1.7.5 Consolidation test

For Type 1 Boots

From the quarter cut a strip of 25.0 ± 5 mm width along the length of the boot and of sufficient length to permit separation over a length of 75 mm. Carry out the test on two test pieces (one from each odd) at the rate of traverse of 100 ± 10 mm/min in accordance with IS 3400 (Part 5) or static based load method as given in Annex D. The individual adhesion value for consolidation test noted / recorded shall be not less than 30 N (3.0 kgf) for each of the test pieces.

In case of dead load method, rate of separation should not be more than 25 mm/min, *Max*.

NOTE — Manual recording may also be done in absence of the machine with auto recording device.

For Type 2 Boots

The individual adhesion value for consolidation test noted/recorded shall be not less than 15 N (1.5 kgf) for each of the test pieces.

In case of dead load method rate of separation should not be more than 25 mm/min, *Max*.

5.1.7.6 Performance test

When boots are subjected to the impact as per prescribed method given in Annex C for examining the protective factor of the boots, they shall be considered to have passed the test, if the clearance inside the boots at the moment of maximum depression is subjected to impact is 13.5 mm, *Min* or more for size 8 and there will be increase and decrease of impact value by 0.5 mm for every size of increase and decrease respectively.

5.1.7.7 Height of the boots

In absence of any agreement between the purchaser and the supplier, height of the Variety No. 1 boots, measured from the seat, shall be 340 ± 5 mm for size 8 with an increase or decrease of 5 mm for each size of increase or decrease respectively.

In absence of any agreement between the purchaser and the supplier, height of the Variety No. 2 boots, measured from the seat, shall be 250 ± 5 mm for size 8 with increase or decrease of 5 mm for each size of increase or decrease respectively.

In absence of any agreement between the purchaser and the supplier, height of the Variety No. 3 boots, measured from the seat, shall be 120 ± 5 mm for size 8 with increase or decrease of 2.5 mm for each size of increase or decrease respectively.

5.1.7.8 Resistance to oil

Type 2 boots, in addition, will be required to comply with the test as prescribed and when tested in accordance with the method as prescribed in Annex E, the increase in volume shall be no greater than 15 percent.

6 MARKING AND PACKING

6.1 Marking

All marking shall be given on the insole/leg lining fabric. Brand/Trade name of the manufacturer, name of the item, month and year of manufacture, size, batch number, license number, Standard Mark, variety and type and name of the manufacturer are to be marked on the insole/leg lining legibly with suitable ink.

6.1.1 BIS Certification Marking

Each boot may also be marked with the Standard Mark.

6.1.1.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and Rules and Regulations made thereunder. The details of condition under which the license for the use of the Standard Mark may be granted to manufacturers

or producers may be obtained from the Bureau of Indian Standards.

6.2 Packing

The right and left boots of each pair shall be packed in a suitable container as agreed to between the purchaser and the supplier.

7 SAMPLING AND CRITERION FOR CONFORMITY

The scale of sampling and criterion for conformity shall be as prescribed in IS 6368 or as agreed to between the purchaser and the supplier.

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	Title	IS No.	Title
1638 : 1969	Specification for sizes and fittings of footwear (<i>first revision</i>)	(Part 4) : 1987	Accelerated aging (<i>second revision</i>)
1969 : 1985	Method for determination of breaking load and elongation of woven textile fabrics (<i>second revision</i>)	(Part 5) : 1986	Adhesion of rubbers to textile fabric (<i>second revision</i>)
		(Part 9) : 1978	Density (<i>first revision</i>)
2050 : 1991	Glossary of terms relating to footwear (<i>first revision</i>)	(Part 16) : 1974	Measurement of cut growth of rubber by the use of the Ross Flexing machine
3400	Method of test for vulcanized rubbers	5852 : 1996	Protective steel toe caps for footwear — Specification (<i>third revision</i>)
(Part 1) : 1987	Tensile stress — Strain properties (<i>second revision</i>)	6368 : 1971	Method for sampling of rubber and rubber combination footwear
(Part 2) : 1995	Hardness (<i>second revision</i>)		

ANNEX B

(Clause 5.1.7.3)

METHOD OF DETERMINATION OF FLEXING ENDURANCE FOR VAMP AND UPPER

B-1 The machine has an adjustable stationary part, provided with grips of 25 mm across for holding one end of each of the test pieces in a fixed position and a similar but reciprocating part for holding the other end of each test piece.

The reciprocating part is arranged so that the motion is in the direction of and in the same plane as the centre line between grips. Its travel is adjusted so that the two sets of grips approach each other to a distance of 57 mm. The eccentric which actuates the reciprocating part is driven by a constant speed motor to give 300 ± 10 flexing cycles per minute for vamp.

The motor should have sufficient power to flex at least six, and preferably twelve test pieces at a time. The test pieces should be arranged in two equal groups so that one group is being flexed while the other group is being straightened, thus reducing the vibration in the machine. The grips shall hold the test pieces firmly and enable individual adjustment to be made to the test pieces.

B-1.1 Test Piece

The test piece shall have the dimension shown in Fig. 6 where the size and the style of the footwear

permits. Test pieces are to be taken out from one article of footwear. In other cases take three or two test pieces whichever is possible from one article of footwear. Test pieces are to be cut from the vamp of the upper.

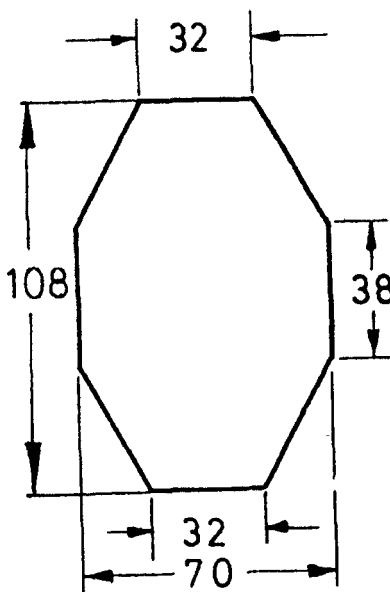
B-2 PROCEDURE

Fold the test piece symmetrically about its major axis so that the rubber surface is outwards. In the folded condition insert one tapered end into the fixed central grip and push in until sample touches the grip pins. Tighten this fixed grip. Take out the corresponding movable grip to its fullest extent; insert the test piece and pull flat and tighten the grip. It is recommended that clips may be used to keep the edges together during the insertion of the test piece in the grips, but their removal is essential before the flexing commences.

NOTE — The test piece should not be under tension.

B-3 EXPRESSION OF RESULTS

A complete to and fro movement of the grip is counted as one flex cycle. Report the number of cycles required to start cracking. The flex cycle may be determined by using a trip counter operated by one of the movable grips.



All dimensions in millimetres.

FIG. 6 TEST PIECE FOR FLEXING TEST

ANNEX C

(Clause 5.1.7.6)

**METHOD OF TEST FOR PERFORMANCE OF PROTECTIVE FOOTWEAR
(APPLICABLE TO ALL TYPES OF PROTECTIVE FOOTWEAR)****C-1 GENERAL**

Performance test is carried out to determine the impact resistance of protective footwear at the end at an energy level of 14 kgf.m.

C-1.1 Test Piece

C-1.1.1 The footwear shall be tested at least after 48 h of vulcanization.

C-1.1.2 The test shall be conducted at the toe of the footwear incorporated with protective steel toe cap, sampled out from both sides of a lot.

C-1.1.3 Preparation of Test Piece

Prepare the test piece from the forepart of the footwear by cutting off the toe end approximately 20 mm beyond the rear edge of the incorporated protective steel toe cap, taking care that the lining is not separated. Make a notch on this 20 mm extended upper inline with the test axis to have clear view of the position of the plasticine cylinder in relation to the incorporated protective steel toe cap.

If the footwear has a removable insole, carry out the test with it in place.

C-2 DETERMINATION OF IMPACT RESISTANCE**C-2.1 Apparatus****C-2.1.1 Impact Apparatus**

The impact apparatus incorporates a solid steel striker of mass 27.2 ± 0.2 kg to fall freely on vertical guides from a predetermined height to give the required energy, calculated as potential energy.

The steel striker strikes a vertical cylindrical steel plunger 38 mm in diameter and 145 mm in height. The upper end of the plunger shall mount a 63 mm \times 63 mm \times 10 mm thick steel plate and a 155 mm \times 38 mm \times 10 mm thick horizontal steel striking plate shall be securely fitted to the lower end of the plunger. Both the plates are replaceable.

The base of the impact apparatus shall be made from hard wood of about 75 mm thickness. The vertical guides, housed in aluminium brackets, shall be secured to the wooden base. A solid steel block of 50 mm thickness, fitted with a 10 mm thick replaceable steel plate, shall be mounted on the wooden base. The steel block shall be supported by two steel angle blocks to prevent sideway movements during the impact.

C-2.1.2 Clamping Device

The clamping device shall consist of a 150 mm \times 150 mm \times 10 mm thick thoroughly machined steel

clamping plate with M-10 threaded hole, a clamping allen screw with M-10 thread, an adjusting screw (Fig. 9) and a stabilizing fork (Fig. 7).

C-2.1.3 A plasticine cylinder of 20 mm diameter and of 20 ± 1 mm height (*see* Fig. 8).

C-2.1.4 A dial vernier calliper or a dial gauge with foot and anvil.

C-3 PROCEDURE**C-3.1 Clamping of the Test Piece**

Place the test piece on the clamping base and insert the stabilizing fork, incorporating the plasticine cylinder in its slot (*see* Fig. 10). Push the stabilizing fork further inside the test piece so that its tips touch the inner lining.

Now, adjust the plasticine cylinder with gentle care in such a way that the rear edge of the incorporated protective steel toe cap. Fix the stabilizing fork by means of the clamping screw to rest on the insole and tighten the same. Now adjust the adjusting screw to make the stabilizing fork parallel to the clamping plate. Thereafter both the clamping and adjusting screws are to be adjusted alternatively, maintaining the parallelism, to ensure firm opening of the test piece.

Now, place the securely clamped test piece under the horizontal striking plate of the vertical cylindrical plunger. Position the horizontal striking plate approximately 1 mm inside the rear edge of the incorporated steel toe cap. The horizontal striking plate shall rest on the test piece lengthwise roughly at right angle (*see* Fig. 11).

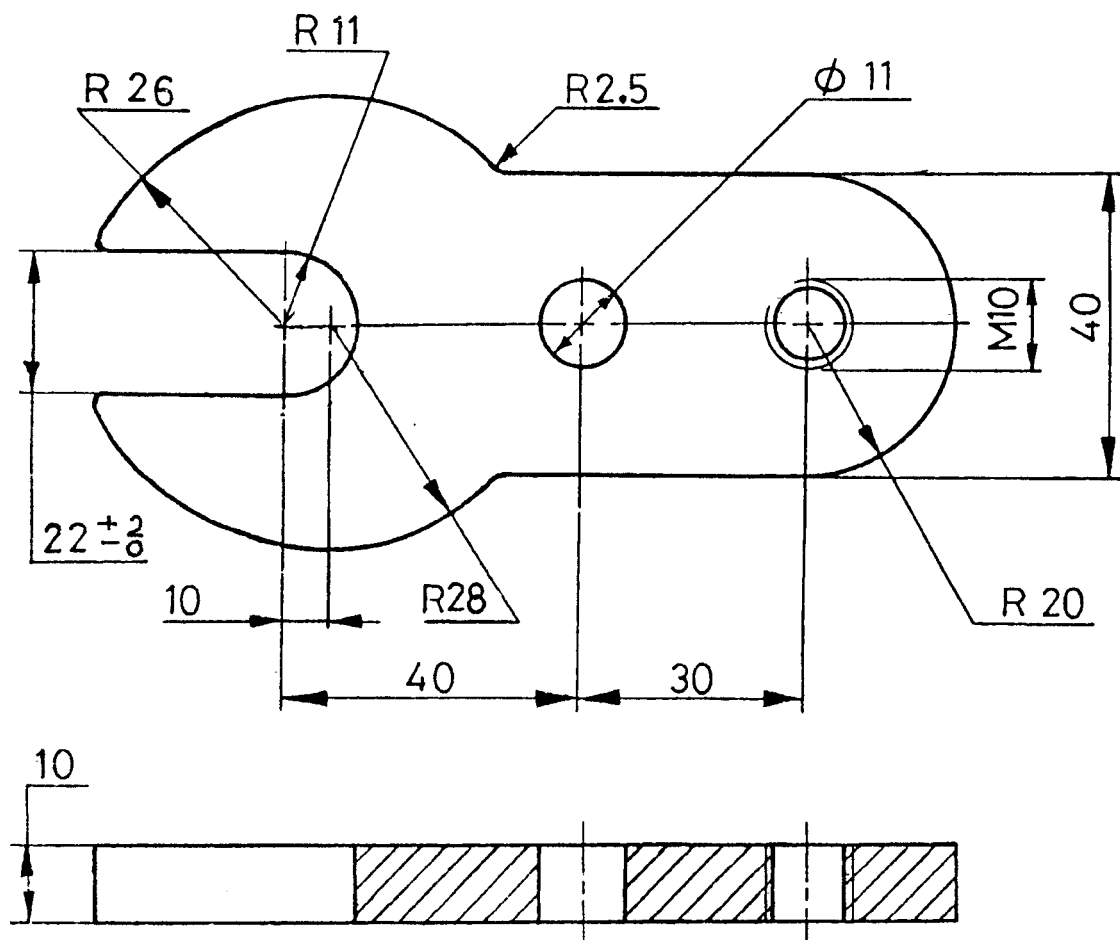
Finally, recheck the proper positioning of the plasticine cylinder in relation to the rear edge of the incorporated protective steel toe cap.

C-3.1.1 Impact

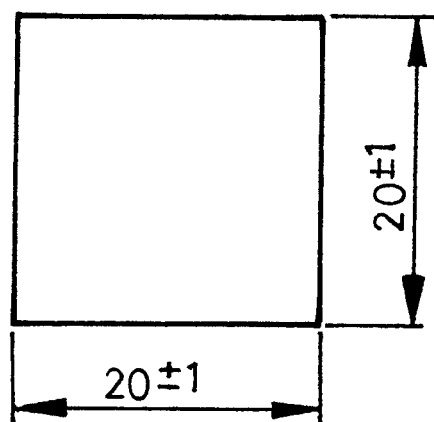
Adjust the solid steel striker to a height of 505 ± 5 mm above the top steel plate of the vertical cylindrical plunger and release it to fall freely and thus the impact energy shall be of 14 kgf.m.

C-3.1.2 Measurement

Remove the plasticine cylinder carefully by unclamping the test piece and measure the height from top of the base of the plasticine cylinder to the nearest 0.5 mm. Special care is to be taken to ensure that the foot/arm of the measuring instrument has not stuck into the flat surface of the plasticine cylinder.

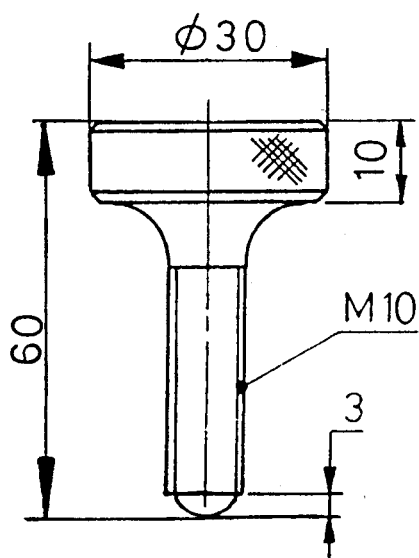


All dimensions in millimetres.
FIG. 7 STABILIZING FORK



NOTE — Flat ends may be covered with aluminium foil.

All dimensions in millimetres.
FIG. 8 PLASTICINE CYLINDER



All dimensions in millimetres.
FIG. 9 ADJUSTING SCREW

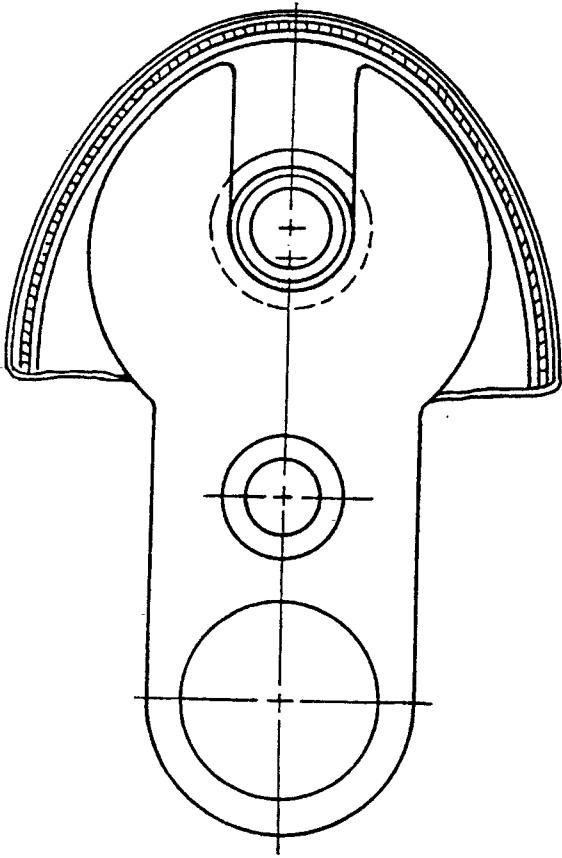


FIG. 10 PLACEMENT OF THE TEST PIECE

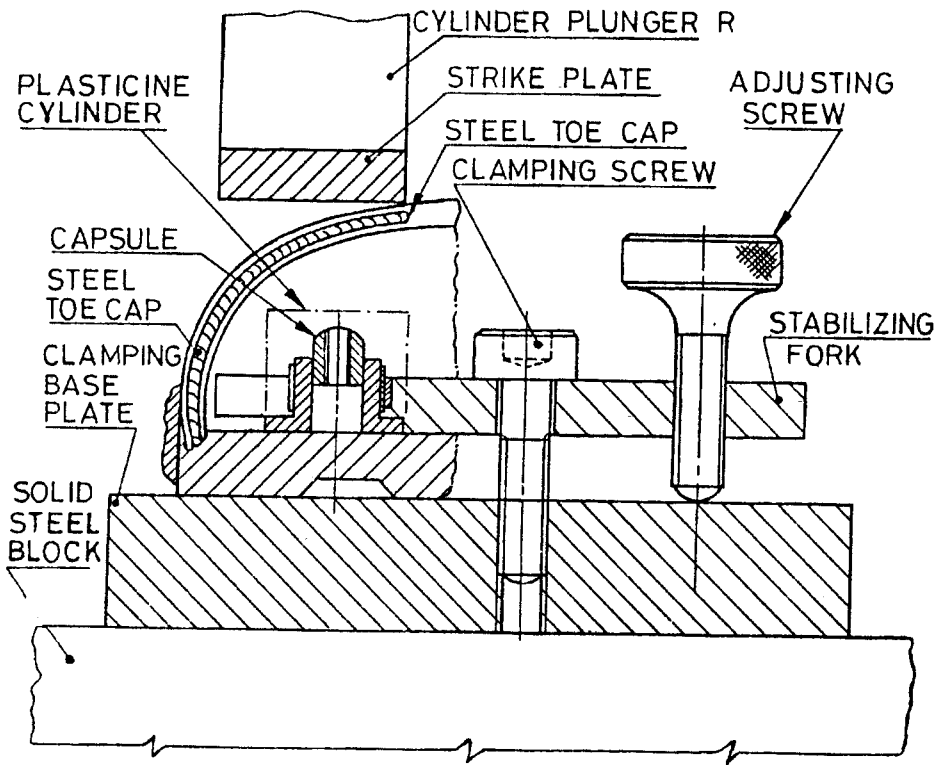


FIG. 11 POSITIONING OF THE TEST PIECE DURING PERFORMANCE TEST

ANNEX D

(Clause 5.1.7.5)

CONSOLIDATION TEST

D-1 STATIC DEAD LOAD METHOD

D-1.1 Apparatus

The apparatus required for the adhesion test by the static mass method consists of a supporting frame, testing clamps, mandrels, calibrated weights, and weight carriers. The supporting frame shall be of such design that clamps for strip specimens hang on it vertically and mandrels for rings specimens are supported on it horizontally. The frame shall have sufficient height to permit the weight carrier to be suspended from the test specimens by means of clamps and shall hang freely during the progress of the test, provision shall also be made to support the mandrels so that they revolve freely with minimum friction.

D-1.2 Calibration of Apparatus

Calibrate the weights annually.

D-1.3 Cutting Tool

Maintain the cutting tool carefully so that the edge is sharp enough to avoid leaving ragged edges and pulling outside threads from the fabric.

D-2 PROCEDURE

D-2.1 Strip Test Piece

Separate the parts of the strip to be tested by hand at one end of the strip specimen and at a sufficient distance to permit the jaws of the testing clamp to be attached. Suspend the strip on the spike of the vertical

frame or board and attach the ply to be separated to the grip. Attach the loaded scale pan to the grip through a light spring. The total mass of the grip, spring, loaded scale pan and attachments shall be taken as the applied load. Obtain either the load required to cause separation of 25 mm/min graphically by selecting various loads or for a known or specified load, determine the rate of separation. Repeat the procedure on the separate plies from the face ply to the centre ply. Test the second specimen commencing with the back ply and proceeding again to the centre ply.

D-2.2 Expression of Results

Express the result as average force, in kilonewtons per metre, width required to cause a separation of the plies at 25 mm/min or obtain the rate of separation at a known or specified load.

D-3 REPORT

The report shall include following: (a) Adhesion value, that is median, range, statistical minimum observed minimum, observed maximum. (b) The type of specimen and thickness of specimen. (c) All observations and recorded data on which the results are based. (d) Date of manufacture or vulcanization of rubber, if known. (e) Date of test. (f) Statement of the method used (Dead load/Static mass or dynamic on constant traverse). (g) Temperature of the test and its duration, and temperature and relative humidity of conditioning.

ANNEX E

(Clause 5.1.7.8)

METHOD OF TEST FOR OIL RESISTANCE

E-1 GENERAL

Samples shall be taken from the soles, the heels and the upper part of the boot to be tested. Any fabric adhering to the upper shall be removed by buffing or other suitable means before proceeding with the test.

E-2 CONDITIONING OF TEST PIECES

The test pieces shall be conditioned for not less than 3 h at $27 \pm 2^\circ\text{C}$.

E-3 TEMPERATURE OF TEST

The test temperature shall be the same as that chosen for conditioning.

E-4 DURATION OF TEST, $24 \pm \frac{2}{0}$ h.

E-5 IMMERSION LIQUID

E-5.1 2.2.4 — Tri Methyl Pentane, 85 percent (v/v).

E-5.2 Toluene, 15 percent (v/v).

NOTE — The materials shall be chemically pure.

E-6 SIZE OF TEST PIECES

For the soles and heels of the boots, the test pieces shall be 1 to 3 cm^3 in volume and of a uniform thickness of $2.0 \pm 0.2\text{ mm}$.

For the upper part of the boot, a test piece of 1 to 3 cm^3 in volume shall be prepared after removal of the fabric, the area depending on the thickness, but neither the length nor the breadth shall be greater than 50 mm .

E-7 APPARATUS

A stoppered glass bottle or tube shall be used, its dimensions being such that, the test pieces remain completely immersed in the immersion liquid and are freely exposed at oil surfaces without restraint.

E-8 PROCEDURE

E-8.1 Three test pieces shall be used. Each test piece shall be weighed in air to the nearest milligram (mass, m_1) and then in distilled water at the standard laboratory temperature (mass, m_2) care being taken to ensure that all air bubbles are removed.

E-8.2 The test pieces shall be blotted dry with filter paper or with a textile fabric that does not deposit lint,

and then placed, suitably separated, in a glass container with a volume of the immersion liquid at least 15 times the combined volume of the test pieces and sufficient to keep them totally immersed.

E-8.3 The container shall be stoppered, kept at the required temperature and the rubber shielded from light during the test.

Only test pieces of the same vulcanizate shall be placed in any one container. If the density of the rubber is less than that of the liquid, a means shall be provided for holding the test pieces completely below the surface of the liquid.

E-8.4 At the end of the immersion period, surplus immersion liquid shall be quickly wiped from the test pieces with filter paper or textile fabric which does not deposit lint, each test piece then being placed immediately in a tared and stoppered weighing bottle; and its mass in air determined (mass, m_3) to the nearest milligram. The test piece shall then be removed from the bottle and immediately weighed in distilled water (mass, m_4) at the standard laboratory temperature. The time for each transference of the test pieces after removal from the immersion liquid shall not exceed 30 s .

E-9 CALCULATION

The change in volume shall be calculated as follows:

$$V = \frac{(m_3 - m_4) - (m_1 - m_2)}{m_1 - m_3} \times 100$$

where

m_1 = initial mass of test piece in air,

m_2 = initial mass of test piece in water,

m_3 = mass of the treated rubber test piece in air, and

m_4 = mass of the treated rubber test piece in water.

The results of the three test pieces shall be averaged.

The maximum time between the date of manufacture, where known, and testing shall be 3 months. Where the date of manufacture is not known, the maximum time for testing shall be 6 weeks from the date of receipt.

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